Discrete Velocity Method for Simulating Rarefied Gas Flows with Plasma

Completed Technology Project (2016 - 2020)

Project Introduction

I am proposing to develop a low cost computational method capable of simulating conditions during atmospheric reentry, where the flow is rarefied and ionized. To do so, I intend to modify an existing discrete velocity method (DVM) so it can handle electric and magnetic fields, as well as charged particles (ions and electrons). DVM is a Boltzmann equation (governing equation for flows where the motion of individual molecules must be considered) solver that restricts particle velocities to a finite set of values. The DVM in its current state is capable of modeling ions and electrons as another particle species. Chemical reactions that generate these particles will be added into the code. Electric and magnetic field calculations will be accomplished by a numerical solver. Code efficiency will be improved primarily through the implementation of adaptive velocity, spatial, and internal energy grids. This means that the resolution for these values can be adjusted on the fly. Doing so allows for improved solution quality only in flow regions of interest, minimizing the cost associated with the higher quality solution. Development of a low cost method for simulating atmospheric reentry conditions will allow us to better develop vehicles capable of operating in these conditions. Current computational methods for simulating rarefied gas flows require supercomputers and are not suited for handling trace species that have a significant impact on the flow. The DVM I propose to modify only requires a single core and is capable of simulating trace species accurately, This proposal addresses objectives in NASA's Entry, Descent, and Landing Technology Roadmap, specifically TA09.4.5.12, TA09.4.5.2, and TA09.4.5.6.

Anticipated Benefits

Development of a low cost method for simulating atmospheric reentry conditions will allow us to better develop vehicles capable of operating in these conditions.

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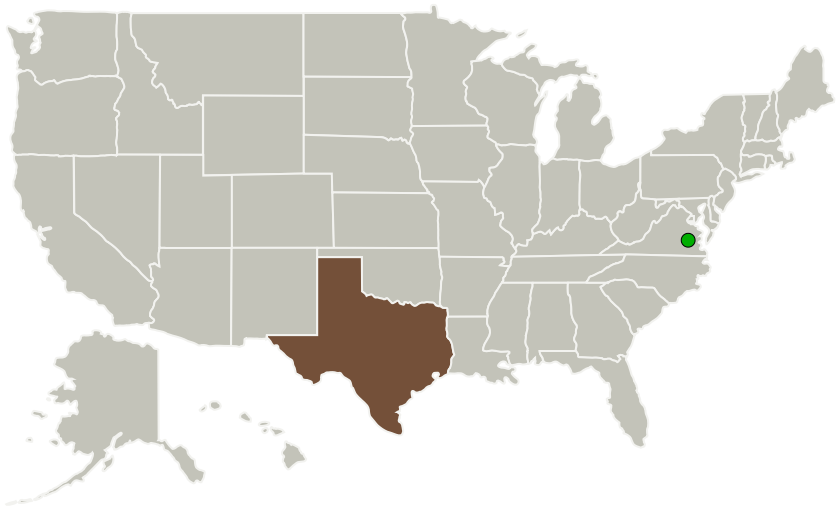
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
The University of Texas at Austin	Lead Organization	Academia	Austin, Texas
Langley Research Center(LaRC)	Supporting Organization	NASA Center	Hampton, Virginia

Primary U.S. Work Locations
Texas

Project Website:

https://www.nasa.gov/strg#.VQb6T0jJzyE

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

The University of Texas at Austin

Responsible Program:

Space Technology Research Grants

Project Management

Program Director:

Claudia M Meyer

Program Manager:

Hung D Nguyen

Principal Investigator:

Philip L Varghese

Co-Investigator:

Yasvanth Poondla

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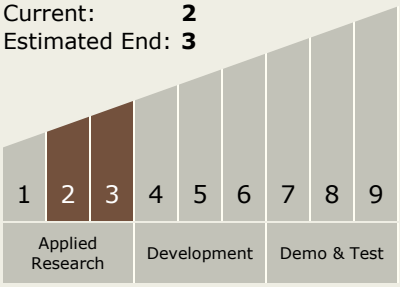
Technology Maturity (TRL)

Start: **2**
Current: **2**
Estimated End: **3**



Technology Areas

Primary:

- TX15 Flight Vehicle Systems
  - TX15.1 Aerosciences
    - TX15.1.5 Propulsion Flowpath and Interactions

Target Destinations

Earth, Mars, Others Inside the Solar System